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A Situation Report

FERTILIZER-PESTICIDE MIXTURES



Agricultural Research Service

UNITED STATES DEPARTMENT OF AGRICULTURE

This report summarizes present information on the rapidly increasing use of fertilizers and pesticides in combination, and varied problems which the practice presents. The information given is based primarily on data obtained from State experiment station workers, pest control officials, and fertilizer manufacturers. The material presented is not intended to convey recommendations from the United States Department of Agriculture.

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## FERTILIZER-PESTICIDE MIXTURES

Dual-purpose mixtures, containing a fertilizer and a pesticide, give the farmer the opportunity to do two important field jobs in one operation. Advantages--but also varied problems--involved in this idea of applying a pest-killer along with crop nutrients have been recognized in the United States for at least 25 years. Until World War II, commercial production of such mixtures stayed small. But in recent years, the demand has grown rapidly. Tonnage last year increased 71%. Meanwhile fertilizer-pesticide mixtures have been gaining use in a number of other countries, also.

The rise in popularity of these two-purpose mixtures has been linked, in part at least, with introduction of new organic insecticides. One way of applying these potent chemicals to control certain insects is to add them to fertilizer.

In most of the present-day mixtures (95%), an insecticide is the pesticide chosen to accompany a fertilizer. However, some mixtures contain a weed-killer or a fungus-killer; and in experimental mixtures nematode control chemicals have been tried.

To date, commercial use of fertilizer-pesticides outstrips research findings about them. This is shown by the differing opinions as to merits and practicality of the mixtures. Recommendations regarding fertilizer-pesticides vary widely, not only from State to State but even among agencies in the same State. The unanswered questions, the problems, and the increasing use all focus attention on need for expanded information on production, distribution, application and effectiveness of the mixtures.

Where farmers get even moderately good results with the mixtures, production can be expected to continue and probably to spread, especially in the North Central area.

Plant nutrition specialists of the Agricultural Research Service have compiled available information on these mixtures and their use for the last few years, in order to learn more about demand for these farming aids, the ways in which they are used, what ingredients they contain. The facts and figures have come chiefly from State sources. Although admittedly incomplete, they bring into clearer focus a geographic picture of use, and also the potential value of the dual-purpose mixtures and the problems concerning them.

All data on fertilizer-pesticide mixtures reported herein deal with commercial mixtures. Because of the difficulty of blending a fertilizer and a pesticide into a uniform mixture, the production of these is a commercial operation, rather than one suitable for a farmer to undertake.

## THE GEOGRAPHIC PICTURE

Fertilizer-pesticide mixtures are registered or sold in 40 States and Puerto Rico, according to latest figures compiled from 1953-54 records kept by fertilizer control officials. Actually, the mixtures are believed to be sold in almost every State and Territory, since some States do not require registration of mixes as such, and others do not require registration of custom mixes.

In all but two regions, use of the mixtures increased in 1953-54 (Table 1). The South Atlantic continued as the region leading in mixture use, and half of the entire country's tonnage was applied there. The most spectacular advance, however, occurred in the West North Central region, where tonnage jumped from 2,000 to 42,600 tons--or more than 2,000%. These two regions together accounted for more than three-fourths of the total use and for 87% of the year's increase.

South Carolina--which pioneered in making extensive use of the mixtures--continues to be the leading State in quantities used, and last year applied 30,000 tons.

Although the year's total increase of 62,000 tons represents a 71% advance, fertilizer-pesticide tonnage still represents less than 1% of the mixed fertilizer tonnage used in the United States. (See last column of Table 1.) Table 1 is compiled from reports of State and Federal agencies and fertilizer manufacturers.

## HOW THE MIXTURES ARE USED

The chief pests that United States farmers sought to control with mixtures in 1953-54 were corn rootworms and wireworms in corn, potatoes, and other crops. Of the 149,100 tons of mixtures used, at least two-thirds served this purpose.

The corn crop received more than half of all the fertilizer-pesticide tonnage used in this country. According to one estimate, Iowa applied mixtures to 362,500 acres of corn; Nebraska to 220,000 acres; Illinois to 12,500 acres. The remainder of the tonnage was applied mostly to potatoes, sugar cane (in Puerto Rico) and vegetables. Figures from Hawaii are not available, but the pineapple growers are known to order some mixtures from Mainland firms and to use locally-prepared mixtures as sprays on foliage.

Varied uses found for the mixtures are illustrated by South Carolina's distribution of 30,000 tons to more than 108,000 acres:

Corn: 100,000 acres to control sand wireworms, corn rootworms, and seed-corn maggots.

Irish potatoes: more than 5,000 acres to control wireworms.

Pastures: 1,200 acres to control white grubs.

Table 1. --Estimated Regional Consumption of Fertilizer-Pesticide Mixtures, 1952-53 and 1953-54

[In short tons]

Region	Fertilizer-pesticide mixtures:		All mixed fertilizers, 1953-54
	1952-53	1953-54	
<u>New England</u> (Conn., Maine, Mass., N.H., R.I., Vt.) - -	400	950	352,000
<u>Middle Atlantic</u> (Del., D.C., Md., N.J., N.Y., Pa., W.Va.) -	1,000	1,800	1,838,000
<u>South Atlantic</u> (Fla., Ga., N.C., S.C., Va.) - - - - -	60,000	73,200	5,022,000
<u>East North Central</u> (Ill., Ind., Mich., Ohio, Wis.) - - - -	2,500	6,700	3,621,000
<u>West North Central</u> (Iowa, Kans., Minn., Mo., Nebr., N.Dak., S. Dak.) - - - - -	2,000	42,600	1,343,000
<u>East South Central</u> (Ala., Ky., Miss., Tenn.) - - - - -	200	1,200	2,040,000
<u>West South Central</u> (Ark., La., Okla., Tex.) - - - - -	100	100	713,000
<u>Mountain</u> (Ariz., Colo., Idaho, Mont., N. Mex., Nev., Utah, Wyo.) - - - - -	1,100	1,450	56,000
<u>Pacific</u> (Calif., Oreg., Wash.):	11,100	11,100	273,000
<u>Puerto Rico</u> - - - - -	8,700	10,000	283,000
Total - - - - -	87,100	149,100	15,541,000



Sweetpotatoes: 1, 000 acres to control wireworms and flea beetles.

Snap beans: 1, 000 to control seed-corn maggots.

South Carolina farmers applied some mixtures also to cotton to control sand wireworms; to truck crops to control mole crickets; and to lawns to control white grubs. In this area the per acre rate of application of mixtures is usually much higher than in the Midwest.

A more general picture of regional use of the mixtures is given in Table 2.

## CHOICE AND PRODUCTION OF MIXTURES

Fertilizer-pesticide combinations in the United States are generally custom-mixed to suit a particular farm situation. Most fertilizer plants do not carry such mixtures in stock.

Fertilizers chosen for use in mixtures usually contain two or more of the primary plant nutrients (nitrogen, phosphoric acid, potassium). There are about 1, 700 formulations of mixed fertilizers marketed in this country. Many of these are used with pesticides. Occasionally, a pesticide is added to a single fertilizer material, such as ammonium sulfate, superphosphate, potassium sulfate, or gypsum.

Pesticides chosen for the mixtures are predominantly (95%) insecticides. The remaining 5% are added to a fertilizer for fungus or weed control. Herbicides in these combinations are used in many areas for lawns and turf, though the total quantity is small.

Aldrin was the insecticide used in greatest quantity in mixtures last year. Chlordane ranked second, and DDT probably third. The principal weed killer used in the mixtures was 2, 4-D. Seldom, if ever, is more than one pesticide added to a fertilizer.

How a mixture will be applied must be known in order to provide a suitable formulation. Since the fertilizer comprises most of the mixture, farmers customarily use their fertilizer distributing equipment. Their customary fertilizing practices likewise guide them in deciding whether to broadcast or drill, and at what time to do the job. If these choices of timing and method would be badly out of line with effective use of the pesticide, then a compromise is a practical solution--provided it would give reasonably good results.

Forms of the mixtures vary but solids prevail. The preferred form for pesticides has been powder. However, there is rapid increase in use of granular insecticides with a particle size range of 30 to 60 mesh. The pesticide forms chosen for use in mixtures also include some emulsion concentrates and solutions in low-viscosity solvents. The latter may gain in use because the liquid insecticide can be sprayed conveniently either on powdered or granular fertilizers. Granular fertilizers (like granular insecticides) are expanding in production.



Table 2. -- Present Regional Use of Mixtures, Including Principal Pesticides Used  
and Pests Combated

Regions	Pesticides	Pests
<u>New England</u> - - - - - (Conn., Maine, Mass., N.H., R.I., Vt.)	Chlordane, DDT, lindane, 2, 4-D	Grubs, wireworms, weeds
<u>Middle Atlantic</u> - - - - - (Del., D.C., Md., N.J., N.Y., Pa., W.Va.)	Chlordane, aldrin, DDT, dieldrin, 2, 4-D	Wireworms, grubs, weeds, seed-corn maggots
<u>South Atlantic</u> - - - - - (Fla., Ga., N.C., S.C., Va.)	Chlordane, aldrin, DDT, dieldrin, heptachlor, tox- aphene, 2, 4-D	Corn rootworms, wireworms, cutworms, elongated flea beetles, grubs, maggots, mole crickets, sweetpotato weevils, weeds, white- fringed beetles
<u>East North Central</u> - - - - - (Ill., Ind., Mich., Ohio, Wis.)	Aldrin, chlordane, DDT, diel- drin, heptachlor, lindane, 2, 4-D	Corn rootworms, wireworms, grubs, onion maggots, strawberry root weevils, weeds
<u>West North Central</u> - - - - - (Iowa, Kans., Minn., Mo., Nebr., N.Dak., S.Dak.)	Aldrin, chlordane, dieldrin, heptachlor, 2, 4-D	Corn rootworms, wireworms, cabbage maggots, grubs, onion maggots, weeds
<u>East South Central</u> - - - - - (Ala., Ky., Miss., Tenn.)	DDT, chlordane, aldrin, hep- tachlor, 2, 4-D	Corn rootworms, wireworms, ants, grubs, weeds, white- fringed beetles
<u>West South Central</u> - - - - - (Ark., La., Okla., Tex.)	Aldrin, dieldrin, lindane, 2, 4-D	Grubs, maggots, weeds, wire- worms
<u>Mountain</u> - - - - - (Ariz., Colo., Idaho, Mont., New Mex., Nev., Utah, Wyo.)	DDT, aldrin, arsenicals, BHC, chlordane, heptachlor, tox- aphene, 2, 4-D	Wireworms, cutworms, grubs, maggots, weeds
<u>Pacific</u> - - - - - (Calif., Oreg., Wash.)	Aldrin, chlordane, DDT, hep- tachlor, IPC, lindane, 2, 4-D	Wireworms, potato flea beetles, strawberry root weevils, grubs, spotted cucumber beetles, weeds
<u>Puerto Rico</u> - - - - -	Aldrin	White grubs

NOTE: The pesticides listed in each regional group should not be interpreted as applied to all  
pests listed for the particular region.

How much pesticide to mix with a ton of fertilizer? Proportions are arrived at by taking into account a number of factors, such as:

- First and foremost, the rate per acre at which the fertilizer will be applied is decided. The rate depends, in turn, on how fertile the soil is, how highly concentrated the nutrients are in the fertilizer, and how the fertilizer will be applied.
- When the rate per acre for the bulkier ingredient is decided, the amount of pesticide to add is determined by considering the kind of pest to be fought, and how serious infestation is likely to be, also the kind of crop and soil.

With such factors considered, the quantity of pesticide combined with a ton of fertilizer is reported to range all the way from 1 to 30 pounds of aldrin; 1/4 to 66 pounds of chlordane; 1 1/2 to 40 pounds of DDT.

In some parts of the country, farms are similar enough in soil fertility, the kind and degree of pest infestation, and crop and fertilizer practices for a small number of fertilizer-pesticide formulations to suit many farms. However, it is more usual for conditions to vary so widely, sometimes even within boundaries of an individual farm, that formulations need to be tailored to suit the field and crop.

Mixing is usually done just before the cured fertilizer is bagged or loaded for shipment. The same equipment that served in mixing the fertilizer itself ordinarily can be used (with due regard for removing residues of a pesticide, such as 2,4-D). But the mixing time is lengthened several-fold to distribute the pesticide uniformly. Even if mixing is prolonged, it may be hard to produce a uniform blend with the usual fertilizer plant equipment if the pesticide and fertilizer differ very much in particle size and bulk density.

Hazards to crop quality appear no less likely to occur when certain insecticides are applied in fertilizer mixtures than when they are applied to the soil separately. BHC and lindane are known to impair flavor and odor of many food crops when applied to soil in which those crops are to be grown. Some other insecticides, when applied heavily or repeatedly, are also suspected of reducing crop quality, but the evidence against them is not so conclusive as it is for BHC and lindane. DDT is highly persistent in many soils and may accumulate enough to impair growth of highly sensitive crops.

New health hazards are introduced into the fertilizer industry with the handling of pesticides, because many of these compounds are poisonous if enough of a vapor or dust is inhaled, accidentally swallowed, or absorbed through the skin.

Manufacturers who take mixture orders generally provide employees with protective devices of some sort. As the volume of this business grows, the hazard is likely to increase. The advisable procedure is for a manufacturer to adopt all health precautions prescribed for the handling and processing of the particular pesticide with which he is concerned. Such precautions would include installing somewhat expensive equipment to keep down dust, which is a familiar nuisance in fertilizer plants.

Farmers or other workers who use a fertilizer-pesticide mixture likewise need to be reminded of health precautions that are advised for those handling the particular pesticide in the mixture.

#### PRICE EXAMPLES

Prices of insecticides when mixed with fertilizers have been compiled from information given by a number of companies last year. For the principal insecticides thus used, they quoted the following range of prices (for 100% technical grade materials):

Aldrin--\$2.00 to \$3.25 per pound  
Chlordane--\$1.00 to \$1.88 per pound  
DDT--\$0.50 to \$0.70 per pound

Some manufacturers stated that their quoted prices did not fully cover all costs of handling, storing, and mixing the insecticide with the fertilizer. In some instances, there was no charge for mixing. In others, the service charge for mixing ranged from \$1 to \$10 per ton of mixture. There is a possibility of the service charge rising, if demand leads plants to make extensive alterations and install additional equipment to handle orders.

The price of fertilizer is increased by about \$22 to \$25 a ton in the South Atlantic area when 8 pounds of aldrin are added to control the southern corn rootworm in peanuts. Applying 500 pounds of the fertilizer-pesticide mixture per acre, as recommended, fixes the cost of aldrin in the mixture at \$5.50 to \$6.25 per acre.

The price of a ton of fertilizer is increased by \$20 to \$30 (usually \$25) in the North Central area when 10 pounds of aldrin are added to control the northern corn rootworm. With applications of one-half to one pound of aldrin per acre, as generally recommended, the cost of the insecticide is usually no more than \$3 per acre.

A mixture costs more than a ton of fertilizer alone--an outlay which may tempt some farmers to reduce the amount of fertilizer they would ordinarily use. Since this can result in a poorer crop, there may be need to remind mixture users of the importance of applying the recommended quantities of both fertilizer and pesticide.

## STATE RECOMMENDATIONS AND REQUIREMENTS

As of June 1954, use of one or more kinds of fertilizer-pesticides was sanctioned in the following 26 States:

Alabama	Kansas	New Mexico	South Dakota
Delaware	Maine	New York	Tennessee
Florida	Michigan	North Carolina	Virginia
Georgia	Minnesota	North Dakota	Washington
Idaho	Mississippi	Oregon	Wisconsin
Indiana	Missouri	Rhode Island	
Iowa	Nebraska	South Carolina	

A State's position on the mixtures is determined by one or more agencies in the State, such as the agricultural experiment station, the extension service, or the State department of agriculture. Sanction of mixtures has generally been accompanied by many reservations on the part of the agricultural officials, even in States using mixtures in considerable quantities. Some recommendations are set forth as tentative or as preliminary suggestions based on limited experimental work. The meagerness of scientific data, which accounts for reservations, partially explains also why sanction of mixture use has been withheld in other States. In some areas, lack of farmer demand is cited as a reason for taking no stand.

Present recommendations in the States for use of fertilizer-pesticides deal chiefly with solid mixtures containing compounds for control of soil-borne insects. For this, the compounds most often recommended are (in order of frequency): aldrin, heptachlor, chlordane, dieldrin, DDT. In a few instances, recommendation is given to such combinations as liquid mixtures containing insecticides, both solid and liquid mixtures for weed control, and pesticidal sprays with urea added.

A number of States do not permit bulk sales of fertilizer-pesticide mixtures, including in this restriction so-called buyers' mixtures and farmers' mixtures.

Few States place restrictions on containers for the fertilizer-pesticides, but some require packaging in heavy paper, and some prohibit use of woven bags for them.

Many States analyze the mixtures for their pesticide content. Few have established tolerances for deficiency or excess of pesticide.

New procedures for obtaining tolerances for pesticides are prescribed in the Pesticide Residue Amendment of 1954 to the Food, Drug, and Cosmetic Act. It is a guiding principle that pesticides should not be used on growing food or feed crops or in soil producing such crops unless tolerances or exemptions from the need of tolerances have been established for the particular pesticide chemical on all the crops involved. Sometimes,



however, it is possible to show that the soil applications will not result in contamination of the harvested food or feed. When such proof is available a tolerance or exemption may not be necessary.

A manufacturer who plans to market fertilizer-pesticide mixtures is advised to check with State officials--also with Federal officials if interstate shipment is planned--to make sure that the intended uses of the mixtures and their labeling are acceptable for registration and that the mixtures would be effective without leaving objectionable residues in soil or on crops.

There is no Federal law specifically regulating fertilizers. But pesticides, including those mixed with fertilizers, if shipped across State lines must be registered with the U.S. Department of Agriculture and must also meet requirements of the Federal Insecticide, Fungicide, and Rodenticide Act. Federal registration for interstate shipment is handled by the Plant Pest Control Branch of the Agricultural Research Service in the U.S. Department of Agriculture. For interstate shipment, any change in the kind or quantity of a pesticide or the kind or grade of a fertilizer is considered a separate product and requires a separate registration.

Whether or not he markets across State borders, a manufacturer must in any case comply with the pesticide and fertilizer regulations in the State where the products are sold. In some States, specific regulations deal with fertilizer-pesticides. In other States, mixtures are registered and fees collected under both the fertilizer and pesticide laws. In still other States, these procedures are handled under only one law.

### SOME PROBLEMS FOR RESEARCH

Knotty problems connected with fertilizer-pesticides that remain to be solved are these:

Fertilizer manufacturers find it difficult, from present information, to formulate two-purpose mixtures to suit each crop and farm. They want to know more specifically:

What types of mixtures will supply desired quantities of both pesticides and plant nutrients at the desired rate per acre, and not leave hazardous deposits of pesticides in the soil?

For success of the mixtures, manufacturers need also to know:

In what conditions will a particular fertilizer-pesticide be compatible and remain stable and effective?

Farmers and their advisers can see that, when the recommended time to apply a fertilizer is also a strategic time to attack a particular crop pest, combining the jobs is practical from a timing standpoint. But they want to know more definitely:

When timing does not fit so neatly, in which situations does it fit well enough to justify combining the jobs--and if jobs are combined, which gets the time preference?

Farmers and their advisers ask also for more guidance on applying a mixture when there is a conflict between preferred ways of handling the fertilizer and the pesticide--such as broadcasting versus drilling. They want to know:

How should a particular mixture be applied when the best way to apply the pesticide differs from the best way to apply the fertilizer?

Officials who regulate and control the sale and distribution of the mixtures are concerned over wide variation in official practices from one area to another. The Association of American Fertilizer Control Officials and the Association of American Pesticide Control Officials, Inc., have called on their respective investigators who deal with the mixtures to survey the situation, as an initial step. They want to know:

What present or possible methods are effective and economical for registering, labeling, managing fees, packaging, inspecting, sampling, and determining tolerances?

Research scientists and equipment manufacturers have speculated on the possibility that a farmer might be able to apply the two types of treatment to a crop without the problems of mixed ingredients. At least one manufacturer is experimenting, in hope of solving this problem by doing away with mixtures, along this line:

Can equipment with twin hoppers be devised at practical cost to apply a pesticide and fertilizer at the same time but separately and each at a different rate?





